Impact of ISO 9001 Standard on the Quality Cost of Construction Projects in the Philippines

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***Abstract*—Since past two decades, ISO 9001 standard has shown its capabilities to lower cost, increase productivity, and satisfy stakeholders (customers) in the organizations. Although ISO 9001 standard has proven its benefits to different sectors in all over the world. But there is still debate among researchers and practitioners concerning the usefulness of applying ISO 9001 in construction projects. However, it seems that among different methods, quality cost analysis is an excellent technique to indicate how much ISO 9001 is able to improve effectively quality performance, and reduce costs in the projects. Thus, the main purpose of this study is to assess the effects of ISO 9001 implementation on quality cost in construction projects. For this aim, a literature review was conducted to design a structured questionnaire in a sample of the 67 respondents from ISO 9001:2008-certified projects of large-scale (AAA) construction companies in Metro Manila, Philippine. As a quantitative research, the inferential statistics analysis used to test the hypotheses of this study. Lastly, the results reported that ISO 9001 standard significantly affects the reduction of quality cost within construction projects in Metro Manila, Philippines.**

***Keywords*—Control Cost, Failure Costs, ISO 9001 standard, QMS, and Quality Costs.**

I. Introduction

ISO 9000 has been widely adopted in the construction industry, and the number of ISO 9001-certified construction firms is growing considerably in many countries [4]. This international standard is one of most effective quality management methods that has implemented worldwide in different industries based on product or service since 1987. This quality management standard is an effective tool to achieve the objectives of the manufacturing and service sectors as well as construction industry. It can assure that all phases of construction project consistently meet client's requirements (need), and having continually improved quality goals. ISO 9001 is a systematic approach (QMS) that aims to promote quality performance continuously based on the implementation of its requirements, documentation procedure, and audit activities. This system can be a part of every project management processes from the moment the project initiates to the final steps in the project closure phase as well [1]. ISO 9001 standard can improve the quality level of production processes in the organizations by its generic guidance, and
powerful methodology, which best known "Plan-Do-Check-Act" cycle, in order to achieve quality objectives successfully.

The majority of construction firms in different scales in developing, or even developed countries believe the adoption of the ISO 9001 is just wasting time and money for consultancy, training, periodical internal and external audit, and certification fee, without any benefit, and the only advantages of ISO 9001 are to cover the requirements of the clients and competitiveness in the market, not more. In against, some studies reported that ISO 9000 has numerous benefits, which can optimize "internal procedures" within construction projects [4]. Furthermore, many construction firms have been tried to establish quality management system (QMS) in their projects by implementing ISO 9001, "but not enough work has been undertaken to assess the quality of the implementation of these QMS in individual construction companies" [13, p. 628]. According to [18, p. 14], quality improvement programs such as ISO 9001 standard can be "critically analyzed using quality costing techniques to check the merit of the program" in the organizations. This method was first introduced by Crosby, as an appropriate method for measuring the performance of quality programs. Also, Juran explained the cost of quality as "cost of poor quality" can be caused by lack or inappropriate quality management implementation. Literature review unearthed that the cost of quality is not often used as an effective technique, or indicator for evaluating the performance of quality management approaches [19], in order to understand the effectiveness of quality management tools like ISO 9001 on the construction projects. However, "construction owners expect contractors to achieve continuous quality improvement by taking all possible measures to ensure the effectiveness of their QMS" [13, p. 612]. Surprisingly, literature review indicated that no study was conducted to examine the impact of ISO 9001 on quality cost, and its main elements.

Thus, the general target of this study was to measure and clarify the effectiveness of ISO 9001 standard on reducing quality cost within ISO 9001:2008-certified projects of large-scale (AAA) construction companies in Metro Manila, Philippines. As a correlational study, literature was first reviewed, in order to design an appropriate questionnaire, then its validity and reliability were tested by content validity and Cronbach's Alpha respectively. Then the questionnaires were distributed randomly among the respondents for

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collecting data. Finally, the simple linear regression was employed to analyze data, find results, and make conclusions for this study.

II. Literature Review

A. ISO 9001 Standard

International Organization for Standardization (ISO) is a worldwide federation of national standards bodies (ISO member bodies), which its intention is to design and present international standards by different technical committees for business, government, and different industries, etc. The most popular standards of ISO is ISO 9000 family or QMS that develop and maintained by ISO/TC 176 committee [8]. In 1987, ISO introduced a set of quality assurance standards, QMS standards originated from the UK standard (BSI 5750) for quality system. ISO 9000 family can improve quality performance of the organizations based on establishing an appropriate system for quality management, this system is able to generate a strategic decision for the organization with the aim of preventing wastes and unnecessary costs during the production processes of the products and services[7]. ISO 9000 family is included four standards, such as, ISO 9000 ("Fundamentals and vocabulary of QMS"); ISO 9001 ("Requirements of QMS"); ISO 9004 ("Managing for the sustained success of an organization"), and; ISO 19011 (Guidance for internal and external audits of quality management systems).

Among these standards, ISO 9001 is the only standard, which is intended to certify the organizations by a third party certification as an evidence that the firm has been worked under a QMS standard [14]. ISO 9001 is included some clauses interpreting the QMS requirements, which are "generic" and applicable for implementing QMS within all organizations, regardless of their type, size and product provided for quality management system, technical committee of ISO is TC-176 that formulates all the standards of ISO 9000 [11]. Interestingly, ISO 9001 standard was promoted as quality management standards since 2000, when the ISO 9001 could adopt a framework based on PDCA cycle for QMS. Thus, ISO 9001 standard offers "a tested framework" to lead "business practices", and to consistently turn out quality products with minimum requirements, which should correspondingly perform for achieving QMS certification in the organizations [14], [12]. In addition, this framework is based on process approach, ISO defined process as a set of interrelated or interacting activities that use inputs to deliver an intended result. The aim of the process approach is to increase an organization's effectiveness and efficiency, in order to achieve its defined objectives such as customer's satisfaction corresponding the requirements, and likewise identifying and reducing the production process problems (e.g. failure, defects, non-conformance, wastes, delay, etc.) with the aim of reducing the quality cost of products or services [7].

B. Costs of Quality

The cost of quality is one of the total quality management (TQM) tools. The cost of quality management system acts as the most appropriate method for "measuring", "monitoring", "controlling" and "decision making" activities in a firm which aims at "business excellence" and also specifies the "non-value added" costs [18]. In the majority of the organizations, quality costs can be often between "10 to 30 percent of sales", or "25 to 40 percent of operating expenses". Some of these costs are visible, some of them are hidden [16]. [3] was first introduced quality cost in his book "Quality Is Free". He justified that "quality is measured by the costs of quality which is the expense of non-conformance as the cost of doing things wrong". Crosby and Juran emphasized on the role quality cost as "the primary management tools", in order to ensure that the quality improvement has been happening through the implementation of quality management program/s [5, 16].

According to [17], the most important issue to improve the competitiveness of any organization is to control and reduce quality costs, and many studies indicated the majority of the companies do not consider this technique as a powerful tool to improve quality of the products and services. Interestingly, 90% of the quality cost is hidden, but 100% or real cost of quality can appear by quality cost analysis. The adoption of quality costs can help the firms to survive in the market, reduce rework costs, and improve the quality of products or services more than those companies do not use this method [18]. In fact, the quality costs can be classified into the four groups that are namely:

1. Prevention costs: These expenses related to costs of design and manufacturing that are directed toward the prevention of non-conformance and defect [10], such as quality planning; new-products review; process planning; process control; quality audits, and; training.
2. Appraisal costs: Those costs are included the expenses of measuring, evaluating, or auditing products of product or process, which assure the products or services are conformance with the specified requirements, standards, and the requirements of the customer in general [9],[15].
3. Internal failure costs: These costs happen when the outcome of product or service process cannot meet designed quality standards and the requirement of the customer, and this failure is found before transfer and delivery to the customer. These costs are Included in this area are scrap; rework; repair; downtime; defect and scrap evaluation [10], and;
4. External failure costs: These expenses generate when products or services cannot satisfy customer or specified requirements but the defects could not be discovered till delivery to the customer. These expenses are customer returns and allowances; repair and servicing; warranty claims; complaints, and; and image [14].

According to [16], the quality costs (Prevention, appraisal, internal and external failure costs) can be categorized into two main groups, which simplifies the analysis of total quality costs in construction industry, the cost of control and

the cost of failure. The breakdown of these costs is shown below:

Quality costs = Control costs + Failure costs (1)
Control costs = Prevention costs + Appraisal costs (2)
Failure costs = Internal failure costs + External failure costs (3)

C. ISO 9001 standard and quality cost in construction

In construction projects, the prevention costs are the expenses of quality activities for preventing "deviations". The appraisal costs are related those expenses that can indicate whether a product, process, or service conforms to customer's needs and requirements. The failure costs are the expenses that project should spend if their product or service could not meet the specific requirements and standards [16]. "The relationship between these costs is reflected in the 1-10-100 rule", one dollar spent on prevention will save $10 on appraisal and $100 on failure costs [17]. Consequently, the companies should not withhold spending money for prevention and appraisal costs, in order to eliminate or reduce failure costs, because of much less costly to prevent a defect than to correct one. Juran's graph can show, how quality program can affect the quality costs (cost of poor quality) of the products or services. This graph is included two axises that are time on the horizontal axis and cost of poor quality on the vertical axis, Juran stated that quality cost or "non-quality" is the best parameter to evaluate quality improvement into the organization. As depict in Figure 1, the minimum level of total quality costs can be obtained, when the quality of conformance is 100 percent (perfection). In the reality, it is impossible to achieve perfection. It is justifiable that prevention and appraisal costs (control costs) increase slowly, while failure costs as well as total quality cost are reducing considerably during implementing quality management tool/s in the firms [9].

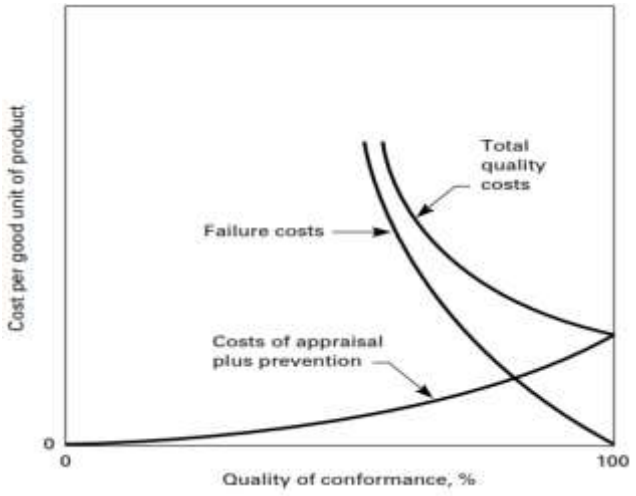

Fig. 1. Model for optimum quality costs juran [10, p. 822]

Indeed ISO 9001 standard as one of the effective quality management techniques has an important role to reduce quality costs in the projects. Some studies were proven its efficiency in saving money within various sectors. According to [20], [21], those organizations that possess ISO 9001 certification can accomplish their performance better, and reduce the expenses of the production processes more than non-certified companies in contrast. Also, [9] asserted that the main purpose of ISO 9001 is to promote the organization's effectiveness and efficiency, with the aim of satisfying customers. Therefore, QMS tries "identifying" and "eliminating" the root causes of the problems during producing the products, or services. This process can help the organization to reduce errors, defects, rework, and delay. Similarly, [21] reviewed 82 articles to specify the most significant advantages of applying ISO 9001 in the organizations. Their findings revealed that the implementation of ISO 9001 can generate positive changes to "reduce mistakes" and "rework", "save on costs" and "improve the management of the firms".

In construction projects, some empirical evidence reported the existence of a direct positive association between ISO 9001 standard and quality costs, for example, [11, p. 210] found that "quality cost reduction", and "prevention of errors from the start" are two of most important achievements of ISO 9001 in construction projects. Likewise, the results of reviewing some empirical studies in construction companies by [6] showed that the average number of defects of ISO 9001-certified construction projects were significantly less than the number of defects of construction projects without ISO 9001 certification. Furthermore, [4] asserted that the case studies indicated ISO 9001 can assist construction project to avoid costly errors and failure. Thus, the reduction of quality costs by implementing ISO 9001 in projects can cause success in construction projects by satisfying stakeholders.

III. Research Framework and Hypotheses

Based on previous discussions, a framework was formulated and presented, in order to investigate and identify the relationships among ISO 9001 standard and the quality cost, and its main elements (control and failure costs) within the construction projects in Metro Manila, Philippines. As depicted in Figure 2, the independent variable of this research framework is ISO 9001 standard and the dependent variables are two main factors of quality costs, such as, failure costs, and control costs. Also, the following hypotheses were developed based on research framework to examine these relationships:

H1: Control costs can be significantly increased during ISO 9001 implementation within the construction projects;
H2: ISO 9001 standard can statistically decrease, or even eliminate failure costs in construction projects, and;
H3: ISO 9001 implementation can minimize quality costs in general.

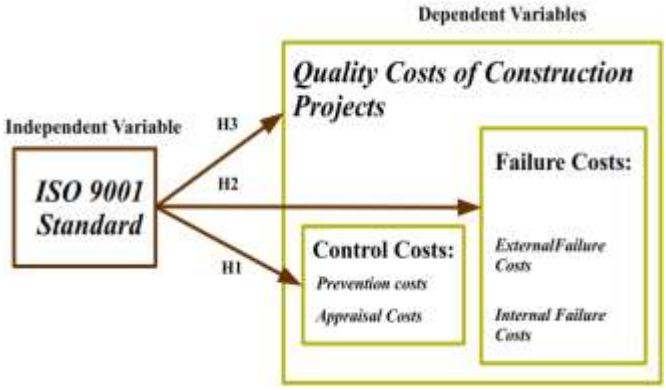

Fig. 2. Research Model

IV. Research Methodology

A. Research Design

As a deductive research, mono method quantitative design was employed to identify the relationships among independent variable as ISO 9001 standard and quality cost variables within ISO 9001:2008 certified projects of large-scale (AAA) in Metro Manila, Philippines. In the first step, the study was carried out an in-depth literature review for determining the research problems, and the main concepts of the research, in order to design an appropriate research instrument related to the content of the study. Then a survey was administered and the questionnaires were randomly distributed among managers working at different levels in construction firms for collecting data. Finally, data was analyzed by inferential statistical analysis to obtain the results and conclusions.

B. Sampling Technique and Sample Size

For sampling, the simple random sampling technique was employed. The researcher distributed the questionnaires randomly to the individuals working in ISO 9001-certified projects of large-scale (AAA) firms in Metro Manila, Philippines. These Large-scale construction firms found and selected from the list of Philippine Contractors Accreditation Board (PCAB). Also, data of the study was obtained from those who worked at management level in construction companies. However, a total of eighty questionnaires that sent to the projects of Large-scale (AAA) construction companies, just 84% of them were duly completed and returned. Accordingly, the response rate of 84% achieved valid out of the 80 questionnaires, or the 67 usable questionnaires were used in the statistical analysis of this research.

C. Data Collection

In this research, secondary data was obtained from scholarly books, articles on ISO 9001 and quality cost technique. Primary data was collected by using the survey instrument. The questionnaire was comprised three sections (30 items). The first section consisted of 24 items concerning the requirements, or clauses of ISO 9001. Second section included two parts, the first part was covered the impact of ISO 9001 standard on control costs (3 items), and part two had three questions, which are related to impact ISO 9001 on failure costs in construction projects. The responses of all items of section I and II were given based on a "five-point Likert-style scale" (e.g. a scale from 1 to 5, strongly disagreement=1, to Strongly agreement=5). The content validity of items was being subjectively evaluated before collecting data by four experts before collecting data. Also, based on obtained data from the survey, the reliability of research instrument was tested by Cronbach's Alpha for ensure to get reliable results.

D. Data Analysis

As a quantitative research, data was analyzed using Statistical Package for Social Sciences (SPSS) Version 17 software. [2] suggested for testing the impact of the independent variable on dependent concepts, simple regression analysis is an appropriate statistical technique. Therefore, this method was adopted using the following regression equations to estimated statistically the effects of ISO 9001 on quality costs, and its elements in construction projects at the significance level of 0.01 and 0.05 (1-tailed):

$$\text{Model 1} = \beta 0+\beta 1*X+\varepsilon \quad (4)$$

$$\text{Model 2} = \beta 0+\beta 2*X+\varepsilon \quad (5)$$

$$\text{Model 3} = \beta 0+\beta 3*X+\varepsilon \quad (6)$$

Where,

Model 1, Model 2, and Model 3 = Impact of ISO 9001 on control costs, failure costs, and quality cost respectively.

$\beta 0$ = Constant of proportionality;

X = ISO 9001 certification;

ε = Error term;

$\beta 1$, $\beta 2$, and $\beta 3$ = Unstandardized regression coefficients of predictors viz, control costs, failure costs, and quality cost respectively

V. Results

A. Reliability and Validity of Research Instrument

In this study, the questionnaire was carefully designed based on previous studies on ISO 9001 standard and quality costs. Then the questionnaire was given to experts for evaluating its content qualitatively (content validity). As stated by [2], for implementing the exploratory and confirmatory factor analysis at least the sample size should be about 100 and 150 respectively. Accordingly, this study was not able to use these statistical methods (exploratory and confirmatory factor analysis) to test the validity of the research instrument, because the sample size is very small (67). However, the reliability of the questions measured by Cronbach's Alpha as most widely used method by researchers to identify and omit the unreliable items of the research instrument. Reliability indicates "internal consistency" of scale items with each other. The alpha value of reliability or the alpha ( ) is between 0 and 1, and each scale α items is reliable that its alpha is at least 0.70 [2]. As presented in

Table I, the overall value of Cronbach's Alpha for the independent variable was about 0.914 that means that the scale items were reliable for ISO 9001 items. While the overall coefficient of quality costs (control and failure costs) is 0.897. Also, Cronbach's Alpha of control and failure costs were 0.826 and 0.833 respectively, which means that all items are an acceptable range. Meanwhile, three items of ISO 9001 measures, and likewise one item of failure costs were identified as unreliable scales, and they dropped before hypotheses testing.

TABLE I: RELIABILITY ANALYSIS

Variable	No. of items before reliability	No. of items after reliability	Cronbach's alpha
ISO 9001	24	21	0.914
Control costs	3	3	0.826
Failure costs	3	2	0.833

B. Hypotheses Testing

As stated previously, simple linear regression analysis was used to examine the three hypotheses of the current study by using SPSS software. Therefore, three Models were developed to calculate statistically the hypothesized relationships among ISO 9001 standard and quality costs, and its main elements (control and failure costs). As shown in Table II and III, the Adjusted R2 is 0.273 in Model 1, which interprets the ISO 9001 standard can explain 27.3 percent of the variance in the dependent variable, or control costs, β coefficient (β1=0.533) and F statistic (F1=25.775) were significant at 0.01 level of significance since p<0.01. Therefore, the model 1 is statistically significant at 1% and the first hypothesis (H1), which is related the impact of ISO 9001 standard on increasing control costs, strongly supported and accepted at 1% significance level from the results. In Model 2, ISO 9001 standard as independent variable accounted with 5% of the variation in the failure costs (Adj. R2=0.05), while the regression analysis statistically has been proven (β2= 0.254; F=4.486) that ISO 9001 can affect the reduction of failure costs at 5% level of significance since 0.038<0.05, while it is not significant at 1% because 0.038 is greater than p=0.01. Consequently, H2 is accepted at 5% significance level only.

TABLE II: SUMMARY OF THE MODELS

Model	R	R Square	Adjusted R^2	Std. Error of the Estimate
I	0.533[a]	0.284	0.273	0.695
II	0.254[b]	0.065	0.050	0.888
III	0.500[c]	0.250	0.239	0.690

Notes: Predictor: (Constant), ISO 9001; Dependent Variable: Control costs[a] Failure costs[b], Quality costs[c]; p<0.01, & 0.05.

Third hypothesis (H3) of this research is concerned the effects of ISO 9001 on total variables of the control and failure costs, or quality costs as whole. According to the regression analysis, the significant values of F (21.685) and standardized coefficient β (β3=0.500) were significant (p<0.01). Whereas the Adjusted R2 is 0.239 that means that the independent variable (ISO 9001) explains (23.9%) the variation in the quality control in general. Thus, the findings of regression analysis can strongly confirm H3 (1%).

TABLE III: REGRESSION ANALYSIS

Model	Sum of Squares	df	Mean Square	F.	Sig.
Regression	20.630	1	20.630	25.775	0.000**
Residual	52.027	65	0.800		
Total[a]	72.657	66			
Regression	3.534	1	3.534	4.486	0.038*
Residual	51.212	65	0.788		
Total[b]	54.746	66			
Regression	10.311	1	10.311	21.685	0.000**
Residual	30.906	65	0.475		
Total[c]	41.216	66			

Notes: Predictor: (Constant), ISO 9001; Dependent Variable: Control costs[a] Failure costs[b], Quality costs[c]; p<0.01, & 0.05.

VI. DISCUSSIONS AND CONCUSSIONS

As stated by [18], [19], [5], [16], [3], [9], [17], quality cost analysis is an effective management tool, or an appropriate indicator to assess the efficiency of quality management programs like ISO 9001 standard, Six sigma, Lean Production, etc. in different industries. Therefore, this study sought to explore the impact of ISO 9001 standard on quality costs and its main factors (control and failure costs) within ISO 9001:2008-certified projects of AAA construction firms in Metro Manila, Philippines. The findings of this study revealed how much ISO 9001 standard can assist construction firms to achieve their goals by reducing the expenses of projects. However, the result of regression analysis showed that the implementation of ISO 9001 increases the control costs (prevention and appraisal costs) into construction projects at 1% significance level. These findings provided supporting evidence for the view of [9], who interpreted that quality management programs can initially increase expenses of the organizations, but the total quality costs will be extremely decreased after a certain period of time, as can be seen in Figure1.

Likewise, the study investigated the impact of ISO 9001 on failure costs in construction projects. Surprisingly, the results revealed that ISO 9001 cannot reduce the failure costs at 1% level of significance, while its effectiveness on failure costs was significant within projects of ISO 9001-certified construction companies at 5% significance level. This outcome from analyzing simple regression is consistent with the studies of [20], [21], who found that ISO 9001 improves the quality performance of the organizations to "reduce mistakes" and "rework", "failure costs" if the standard has been implemented properly. Furthermore, the construction studies reported that the "number of defects" [6] and errors and failure [4] of ISO 9001-certified construction projects are significantly less than the construction projects without ISO 9001 certification. From literature review, the empirical studies of [11], [4] are also supported the findings of this research concerning the significant effects of ISO 9001 on quality costs at 1% significance level in construction projects. Thus, this study concluded ISO 9001 standard is an effective quality management technique that can improve non-stop the quality of construction processes with the aim of reducing the expenses of projects and quality costs.

As can be seen in Table III, two of three hypotheses were accepted at 1% level of significance, and the only hypothesis 2
related to failure costs was significant at 5%. From this finding, it might be justified that the majority of construction companies have been adopted ISO 9001 as a marketing tool instead of using it as an effective management tool to solve their quality problems and eliminate internal and external failure for reducing their expenses. According to [4], this kind of notion can often cause that the construction projects implement ISO 9001 improperly, it is indeed a big challenge and barrier to achieving the advantages of ISO 9001 standard within construction projects. Thus, this study recommended to management of the construction firms in emphasizing more on quality aspects of ISO 9001 (QMS) within projects than commercial and marketing issues only, in order to improve continuously the construction projects' performance and reduce the quality costs of construction processes, which can promote the satisfaction of the customers and owners, and being more competitive. For further study, it is suggested to evaluate how new version of ISO 9001 (2015) can affect quality costs and its main elements in construction projects.

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